भारतीय मानक
Indian Standard

IS 516 (Part 2/Sec 2) : 2020

दृढ़ीकृत कंक्रीट — परीक्षण पद्धतियां

भाग 2 बल के सामर्थ्य के अतिरिक्त दृढ़ीकृत कंक्रीट के अन्य गुण

अनुभाग 2 प्रारंभिक सतही अवशोषण

(पहला पुनरीक्षण)

Hardened Concrete — Methods of Test

Part 2 Properties of Hardened Concrete other than Strength

Section 2 Initial surface absorption

(First Revision)

ICS 91.100.30

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June 2020 **Price Group 6**

Cement and Concrete Sectional Committee, CED 02

FOREWORD

This Indian Standard (Part 2/Sec 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

Testing plays an important role in controlling the quality of cement concrete work. Systematic testing of the raw materials, fresh concrete and hardened concrete is an inseparable part of any quality control programme for concrete. This helps to achieve a higher efficiency of the materials used and greater assurance of the performance of the concrete, in regard to workability, strength and durability. The test methods used should be simple, direct and convenient to apply. This standard was formulated with this objective in view.

This standard was first published in 1959. In this revision, it was decided to review and update the various existing test methods of concrete. The revision of the standard is being brought out taking into consideration the latest international practices and developments in this field in the country and also introduce certain new test methods, wherever required. In the process, the various existing test methods covered in IS 516 : 1959 'Methods of tests for strength of concrete' have been revised taking into consideration primarily the corresponding ISO standards while also examining the other best practices world over and in the country. In addition, test methods for determination of additional properties have been included in areas such as permeability, initial surface absorption, corrosion of reinforcement, carbonation of concrete (field test), accelerated carbonation test, and creep of concrete. Also, for better understanding and implementation, some of the other test methods which were spread over in number of other Indian standards have been brought together under the fold of IS 516 as its various parts, such as the splitting tensile strength, ultrasonic pulse velocity test, rebound hammer test, pull out test for bond in reinforced concrete, and determination of water soluble and acid soluble chlorides. This is with a view to making the standard complete in all respects, and rendering it a comprehensive source of provisions for testing of concrete and reference in other Indian Standards.

In this revision, IS 516 is split into 12 parts. The other parts in the series are:

Part 1	Determination of strength of hardened concrete
Part 3	Making, curing and determining compressive strength of accelerated cured concrete test specimens
Part 4	Sampling, preparing and testing of concrete cores
Part 5	Non-destructive testing of hardened concrete
Part 6	Determination of drying shrinkage and moisture movement of concrete samples
Part 7	Determination of creep of concrete cylinders in compression
Part 8	Determination of modulus of elasticity in compression
Part 9	Determination of wear resistance
Part 10	Determination of bond in reinforced concrete
Part 11	Determination of Portland cement content of hardened hydraulic cement concrete
Part 12	Determination of water soluble and acid soluble chlorides in hardened mortar and concrete

This standard (Part 2/Sec 2) covers the procedures for testing the properties of hardened concrete other than strength, namely initial surface absorption. This is a newly introduced test method. This test method gives data for assessing the uniaxial water penetration characteristics of a concrete surface. The results may be considered to be related to the quality of finish and to the durability of the surface under the effects of natural weathering. The initial surface absorption is the rate of flow of water into concrete per unit area from the start of the test to the end of the test and at a constant applied head. It is applicable to the zone of concrete immediately behind the surface. The thickness of the zone that influences the result of this test may range between a few millimetres and several centimetres depending on the nature and condition of the concrete.

IS 516 : 1959 shall be superseded after the publication of all the parts of the standard.

In the formulation of this standard, assistance was derived from BS 1881 – Part 208 : 1996 'Testing concrete. Recommendations for the determination of the initial surface absorption of concrete'.

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Indian Standard

HARDENED CONCRETE — METHODS OF TEST

PART 2 PROPERTIES OF HARDENED CONCRETE OTHER THAN STRENGTH

Section 2 Initial surface absorption

(First Revision)

1 SCOPE

This standard (Part 2/Sec 2) specifies a method for determining the initial surface absorption of oven dried concrete, non-oven dried concrete in the laboratory and of site concrete. Recommendations are given on areas of application of this method and the interpretation of results.

2 DEFINITIONS

For the purpose of this standard, the following definitions shall apply.

2.1 Location — Region of concrete that is being assessed and that, for practical purposes is assumed to be of uniform quality.

2.2 Initial Surface Absorption — Rate of flow of water into concrete per unit area from the start of the test to the end of the test and at a constant applied head.

2.3 Surface Zone — Zone of concrete immediately behind the surface.

NOTE — The thickness of the zone that influences the result of this test may range between a few millimeters and several centimeters depending on the nature and condition of the concrete.

3 APPLICATIONS

3.1 General

This test method gives data for assessing the uniaxial water penetration characteristics of a concrete surface. The results may be considered to be related to the quality of finish and durability of the surface under the effects of natural weathering. The results are of little relevance to the behaviour of concrete under higher water pressures, and cannot be used to assess the permeability of the concrete.

This test method can also be applied to exposed aggregate or profiled surfaces provided that a watertight seal can be obtained with the apparatus. The test is not applicable to specimens or areas showing obvious porosity, honeycombing or cracking. Misleading results can also be obtained when tests are performed on thin concrete sections through which water could penetrate during the test. Tests shall not be repeated at locations within an area affected by previous tests.

3.2 Quality Control

3.2.1 *Precast Concrete*

The test is most reliably applied to precast concrete units which can be tested under standardized dry conditions.

3.2.2 *In-situ Concrete*

It is difficult to achieve standardized drying conditions for *in-situ* concrete although generalized classification limits relating to surface weathering characteristics have been proposed which can be applied to *in-situ* test results. The method has been successfully used on this basis to assess compliance with specifications for weathering performance.

3.3 Comparability Surveys

Since it is sensitive to surface finish as well as to the quality of the concrete in the surface zone, the test provides a means of comparative assessment for determining the uniformity of concrete between different batches/different structural members of same concrete or for different concretes made with different cementitious materials or different compositions. With careful interpretation, the test may usefully be applied to *in-situ* concrete construction.

4 FACTORS INFLUENCING THE INITIAL SURFACE ABSORPTION OF CONCRETE

The following factors affect the surface absorption of concrete:

a) Moisture conditions;
b) Concrete mix;
c) Aggregate;
d) Surface finish and type;
e) Curing;
f) Age of concrete;
g) Cracking (visible crack should be avoided); and
h) Temperature.

Guidance concerning the influence of the given factors on the interpretation of result in practical circumstances is given in **8**.

Although impurities in the water can influence the rate of absorption, this effect may be disregarded provided that the water is of potable quality. However, distilled or de-ionized water shall be used for calibrating the capillary tube.

5 APPARATUS

5.1 Test Assembly, comprises a watertight cap which is sealed to the concrete surface and connected by means of flexible tubes to a reservoir and a capillary tube with a scale. A control tap is fitted to the connection between the reservoir and cap. A typical test assembly is illustrated in Fig. 1.

5.2 Cap, of any suitable rigid non-corrodible impermeable material providing a minimum area of water contact with the surface to be tested of 5 000 mm^2 (*see* Note). An inlet and an outlet tube are fixed into the cap, the former connecting to the reservoir and the latter to the capillary tube. The outlet is so positioned that it is at the highest part of the cap to allow all trapped air to escape. A suitable cap for clamping onto horizontal concrete specimens with a relatively smooth surface is illustrated in Fig. 2. This has a soft elastomeric gasket to provide a watertight seal. It is possible for the gasket to be glued to the surface of smooth dry laboratory specimens. In cases where either the surface of the concrete is not smooth, or the cap cannot be clamped onto the surface to be tested, the cap should have a knife edge for contact with the concrete. A suitable cap for testing vertical or sloping surfaces or soffits is illustrated in Fig. 3.

NOTE — It is useful for the cap to be made of a transparent material such as a clear acrylic, polyester or epoxy resin (reinforced if necessary) as this allows the operator to observe the filling of the cap with water and the displacement of the air

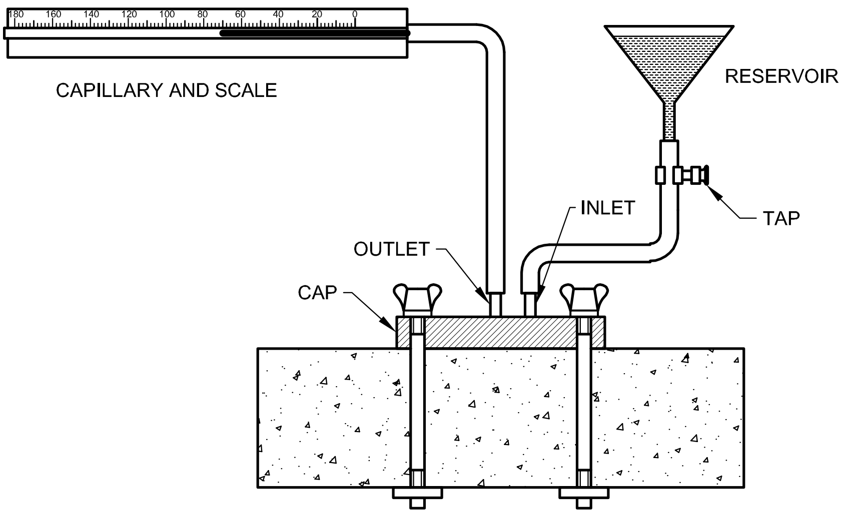

FIG. 1 ASSEMBLY OF TYPICAL ABSORPTION APPARATUS

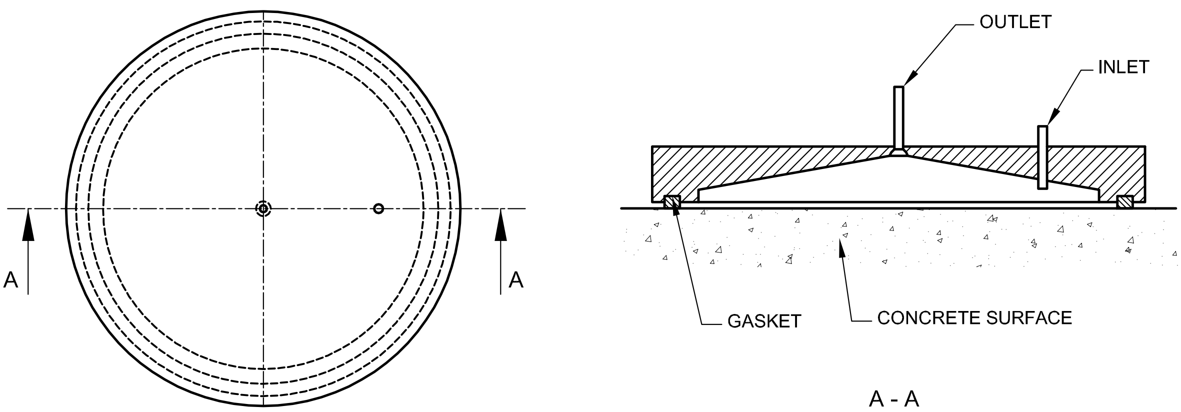

FIG. 2 TYPICAL CAP SUITABLE FOR CLAMPING INTO A SMOOTH HORIZONTAL SURFACE

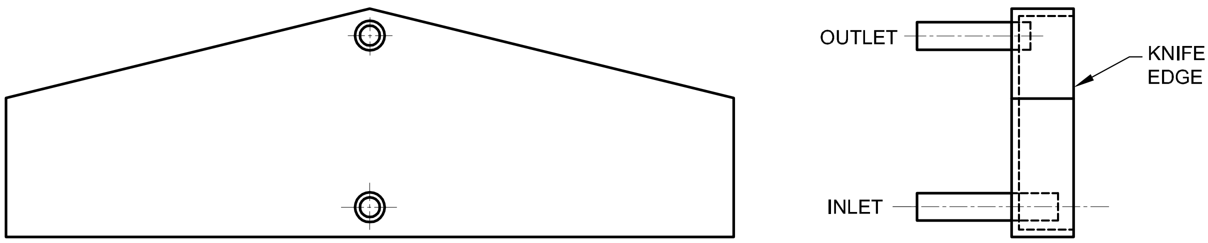

FIG. 3 TYPICAL CAP SUITABLE FOR USE ON A VERTICAL SURFACE

5.3 Connections

5.3.1 *Inlet*

The inlet tube to the cap is connected to the reservoir by a flexible tube of sufficient length to enable a head of water between 180 mm and 220 mm above the surface of the concrete under test to be maintained, and is fitted with a tap.

5.3.2 *Outlet*

The outlet tube from the cap is connected to the capillary tube by a flexible tube of sufficient length to enable the capillary tube to be set horizontally at a head of water between 180 mm and 220 mm above the surface of the concrete under test.

5.4 Reservoir, of glass or plastics material of about 100 mm diameter.

5.5 Capillary Tube and Scale

A length of precision bore glass capillary tubing at least 200 mm long with a bore of 0.4 mm to 1.0 mm radius (*see* Note).

For a cap of the minimum dimensions given in **5.2**, a capillary bore of 0.4 mm radius and concrete of high initial absorption, the length required would exceed 1 m. To limit the length of tube to a convenient value, a combination of cap size and capillary bore shall be chosen to accommodate the range of initial surface absorptions anticipated. The more permeable the concrete, the larger the bore or the length needs to be. The capillary tube protrudes beyond one end of the scale for connection to the outlet of the cap.

NOTE — The length of capillary tubing necessary to accommodate the full range of possible initial surface absorption values indicated in Table 1 will depend upon the radius of the capillary bore and the cap size.

5.6 Stands and Clamps, to support the reservoir and capillary tube and scale, allowing for adjustments within the ranges given in **5.3**.

5.7 Stop Watch or Clock, accurate to 0.5 s.

5.8 Measuring Cylinder, of 10 ml capacity.

5.9 Thermometers, accurate to the nearest 0.2°C, suitable for measuring the temperature of the water and of the concrete surface.

5.10 Drying Oven, ventilated, in which the temperature may be controlled at 105 ± 5°C.

5.11 Cooling Cabinet, dry airtight vessel of sufficient capacity to contain the specimens to be tested.

5.12 Balance, of appropriate capacity to weigh the specimens to the accuracy required by **7.1.2**.

6 CALIBRATION OF APPARATUS

6.1 General

The calibration of the capillary tube is arranged so that the movement of water along it during 1 min, as read directly from the scale, equals the intial surface absorption in ml/(m^2s) at a constant head and temperature during the test.

6.2 Radius of Bore of Capillary Tube

Measure the length of the capillary tube and record it to the nearest millimetre. Flush the tube through with soap solution, followed by at least 25 ml of distilled or de-ionized water. Clamp the tube horizontally and connect it to the reservoir by means of the flexible tube fitted with a tap. Fill the reservoir such that a head of water of 200 ± 5 mm is maintained during the course of the calibration.

Close the tap and fill the reservoir with distilled or de-ionized water to the specified level. Determine the temperature of the water using the thermometer and ensure that this is 27 ± 1°C. Open the tap and when a steady discharge occurs, place the measuring cylinder under the open end and begin to collect the water. Record in seconds, the time required to collect 10 ml of water. Repeat this procedure twice more and calculate the mean of the three. Calculate the

bore radius of the capillary tube, 'r', in mm, from the following equation:

$$r^4 = KL / T$$

where

L = length of the capillary tube, in mm;

T = mean time to collect 10 ml of water, in s; and

K = coefficient incorporating the viscosity of water and the geometry of the apparatus obtained from the values below using the linear interpolation between the adjacent values. For 27°C, the value of K is interpolated as 0.011 6.

Water Temperature (°C)	10	15	20	25	30
Factor K	0.016 7	0.014 5	0.012 8	0.011 4	0.010 0

6.3 Capillary Scale

From the dimensions of the cap, taking account of the geometry, calculate the area of contact of the water with the specimen, A_1 and record this in mm^2. Calculate the area of the bore of the capillary, A_2 in mm^2, as follows, using the value r calculated as described in **6.2**.

$$A_2 = \pi r^2$$

Prepare a scale to mount behind the capillary tube marked off with at least 180 divisions, spaced at $6 \times 10^{-4} \left(\frac{A_1}{A_2} \right)$ mm apart. Each such division will then represent 0.01 units of ml/(m^{2}sec).

7 PROCEDURE

7.1 Selection and Recommended Preparation of Specimens

7.1.1 *Number of Specimens*

Test at least three separate specimens or locations selected to be representative of the concrete under examination and suitable for test with the cap and clamping system to be used. The concrete sections should have a minimum thickness of 75 mm. Areas exhibiting surface cracking should normally be avoided. Mould oil or curing membranes, as well as the procedures needed to remove them, may affect the results.

7.1.2 *Oven Dried Specimens*

Dry the specimen in the drying oven at 105 ± 5°C until constant mass is achieved, that is, not more than 0.1 percent weight change over any 24 h drying period. When the specimen has reached constant mass, place it in the cooling cabinet and allow the temperature in the cabinet to fall within 2°C of that of the room. Leave each specimen in the cabinet until required for testing. Concrete made with high alumina cement shall not be conditioned by oven drying.

7.1.3 *Non-oven Dried Specimens*

7.1.3.1 *Conditioning for laboratory testing*

Allow the concrete unit or specimen to remain in the laboratory for a minimum period of 48 h at a temperature of 27 ± 2°C before testing.

7.1.3.2 *Conditions for site testing*

Protect the surface to be tested from water for a period of at least 48 h prior to the test. Do not allow contact between the protective material and the surface to be tested. Protect the surface from direct sunlight/rainfall for at least 12 h prior to and during the test.

7.2 Fixing the Cap

Slightly grease the gasket where it is made of a solid elastomer. Foamed elastomeric gaskets may or may not need greasing. In the case of knife edged caps, form a seal round the outside of the cap to prevent any loss of water from under the knife edge. A variety of materials can be used, and shall be firmly applied to the concrete and the edges of the cap, to build a wall capable of withstanding the water pressure. Few of the best materials are the silicone gel or modeling clay into which enough grease can be kneaded to enable it to seal the glass or metal. The colour may be selected to match the concrete.

A gentle application of heat to the test surface helps to remove residual moisture and assist in the adhesion of the sealing compound. If this procedure is adopted it should be stated in the report. Clamp the cap into position or fix into place and test by blowing gently down one of the tubes whilst closing the other. Leakage may occur in the course of a test under site conditions due to movement of the seal and can be detected by applying a small amount of soap solution to the outside of the joint. Carefully examine the sealing of the cap throughout each test and if any signs of leakage are observed discontinue the test.

7.3 Assembling the Apparatus

Set up the reservoir so that when it is filled a head of 180 to 220 mm of water is applied to the surface of the concrete (*see* Note).

Connect the reservoir to the inlet of the cap with the flexible tubing, which has the tap fitted to it.

Support the capillary tube, horizontally just below the level of the surface of the water in the reservoir.

NOTE — For non-horizontal surfaces measure the head of water from mid-height of the concrete under the cap.

7.4 Temperature of Water

In laboratory tests maintain the temperature of the water at 27 ± 2°C. In site tests no limits can be laid down, but take precautions to avoid undue fluctuations in the temperature of the water during the test.

7.5 Starting the Test

Measure and report the temperature of the concrete surface adjacent to the cap to the nearest 1°C. Close the tap from the reservoir and fill the reservoir with water.

Start the test by opening the tap to allow the water to run into the cap and record this start time.

Flush all air from cap through the capillary tube, assisted if necessary, by sharply pinching the flexible tubing. Replenish the reservoir to maintain the head of 180 to 220 mm of water and raise one end of the capillary tube just above the water level to prevent further outflow.

Take care at all times to ensure that the reservoir does not empty itself and the water level in the reservoir shall be maintained.

7.6 Readings

Take readings normally after 10 min, 30 min and 1 h interval from start of the test.

As the test proceeds, the moisture content of the concrete will increase and capillary pores within the concrete adjacent to the test area become water filled. The rate of surface absorption will normally diminish as the duration of the test increases.

Just before the specified intervals as per Table 1, lower the capillary tube so that water runs in to fill it completely and then fix it in a horizontal position at the same level as the surface of the water in the reservoir.

At each of the specified test intervals close the tap to allow water to flow back along the capillary tube. When the meniscus reaches the scale start the stop watch. After 5 s, note the number of scale divisions the meniscus has moved and by reference to Table 1, determine the period during which movement is to be measured.

Table 1 Determination of Period of Movement

(*Clause* 7.6)

Sl No.	Number of Scale Divisions Moved in 5 s (*see* Note)	Period During which Movement is Measured
(1)	(2)	(3)
i)	< 3	2 min
ii)	3 to 9	1 min
iii)	10 to 30	30 s
iv)	> 30	Record initial surface absorption as more than 3.60 ml/(m^2sec)

NOTE — 1 division = 0.01 unit (*see* **6.3**).

Record the number of scale divisions moved during the period selected from Table 1. When readings are taken over a 2 min or 30 s period, multiply the number of divisions by 0.5 or 2 respectively to convert the reading to a 1 min period. Record the actual or equivalent number of scale units traversed per min, which is 0.01 times the number of divisions, as the initial surface absorption in ml/(m^2) for that particular test interval. If the movement over the 5 s period exceeds 30 scale divisions record the initial surface absorption as more than 3.60 ml/(m^2sec) .

If the reading taken 10 min after the start of the test is below 0.05 ml/ (m^2sec), stop the test and record the result with the comment 'concrete too impermeable to be sensitive to a longer term test'. Where the 10 min reading is above 3.60 ml/(m^2sec) stop the test and record the result with the comment concrete too permeable to be within the sensitivity of the test method.

Between test intervals leave the tap open and maintain level of water in reservoir at the specified head. The capillary tube may be tilted or raised a little to prevent overflow of the water.

8 FACTORS AFFECTING TEST RESULTS

8.1 General

Detailed interpretation of results will depend upon the purpose and circumstances of use of the test, but the factors influencing results which are described in **4** should be given due consideration.

8.2 Sensitivity to Initial Moisture Condition of Non-oven Dried Specimens

Sensitivity to residual moisture shall not be high in relation to the influence of other factors. If the conditioning was carried out as described in **7.1.3** the effect of such moisture will decrease as duration of the test increases.

8.3 Variability of Concrete

The results reflect the variability, which may be considerable, of the condition of the surface and of concrete properties in the surface zone. Concrete subjected to site or laboratory conditioning is likely to yield more variable results than oven dried concrete. Oven drying may cause changes in the cement paste structure and can give different results from non-oven dried concrete samples.

8.4 Period of Test

For the assessment of potential weathering characteristics or protection afforded to embedded steel or if the test area has not been heated (*see* **7.2**), broad conclusions based on the result of 10 min tests may be considered adequate. However, the effects of moisture condition indicated in **8.2** shall also be considered.

8.5 Temperature of the Concrete

Major variations in the surface temperature of the concrete, from the 27°C value for which the equipment has been calibrated are likely to influence results

significantly owing to changes in viscosity of the water. The correction factors given in Table 2 should be used to convert site results to an equivalent 27°C values.

Table 2 Correction Factor to Convert Readings to an Equivalent Value at 27°C

(*Clause* 8.5)

Sl No.	Concrete Surface Temperature °C	Multiply by
(1)	(2)	(3)
i)	5	1.7
ii)	10	1.5
iii)	15	1.3
iv)	20	1.2
v)	25	1.1
vi)	27	1.0
vii)	30	0.9
viii)	35	0.8
ix)	40	0.7

9 TEST REPORT

The following information should be included in the test report on each specimen or each location, as may be relevant:

a) Date, time and place of test;
b) Age of concrete under test (if known);
c) Identification and description of test specimen or element;
d) Location within the element, where applicable;
e) Positions tested, where applicable (with sketches);
f) Detailed description of the surface of the concrete;
g) Orientation of the test surface (horizontal, vertical or other direction);
h) Description of the conditioning prior to test (including surface heat treatment);
j) Method of sealing the cap;
k) Area of water contact of the cap, dimensions of the cap and length of the capillary;
m) Temperature of the concrete surface;
n) All initial surface absorption test results, in ml/(m^2s) as obtained in **7.6**; and
p) Results corrected to equivalent 27°C values.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

Organization	*Representative(s)*
In Personal Capacity (*Grace Villa, Kadamankulam P.O., Thiruvalla 689 583*)	Shri Jose Kurian (***Chairman***)
ACC Ltd, Mumbai	Shri Rajesh J. Modi Dr Manish V. Karandikar (*Alternate*)
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Indian Association of Structural Engineers, New Delhi	Shri Mahesh Tandon Shri Ganesh Juneja (*Alternate*)

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The India Cements Limited, Chennai	Representative
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Member Secretaries

Shrimati Divya S.
Scientist 'C' (Civil Engineering), BIS

and

Shri Milind Gupta
Scientist 'C' (Civil Engineering), BIS

Concrete Subcommittee, CED 2 : 2

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(*Continued from second cover*)

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

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